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## SOME MARINE CYANOPHYCEAE FROM THE SHIRAHAMA COAST OF WAKAYAMA PREFECTURE\*

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*With 3 Text-figures*

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Shirahama of Wakayama Prefecture is located on the southwest coast of the Kii Peninsula, and is well known as hot-spring town from old times. The Marine Biological Laboratory, Faculty of Science, Kyoto University is situated in the town, and many zoologists and algologists visit it for collecting materials or for other biological studies.

The late Dr. K. OKAMURA (1932) reported on the algal flora of this coast, but he did not touch upon the marine Cyanophyceae. So far as the writer is aware no one has previously made a collection concerning the marine Cyanophyceae of this region. Therefore the study of the flora of marine Cyanophyceae of this coast seems to the writer both interesting and important. The writer made three journeys in May, August and November, 1951, to Shirahama for this purpose.

The species identified amount to 39 in all, of which 3 belong to the Chroococcaceae, 6 to the Pleurocapsaceae, 1 to the Dermocarpaceae, 2 to the Mastigocladaceae, 5 to the Rivulariaceae and 21 to the Oscillatoriaceae. *Microcoleus tenerrimus* GOM. var. *longus* is described as new variety. *Aphanocapsa littoralis* HANSG. var. *macrococca* HANSG., *Pleurocapsa minuta* GEITL., *Pl. fuliginosa* HAUCK, *Xenococcus Gilkeyae* SETCH. et GARDN., *Hyella Balani* LEHM., *Myxohyella socialis* (SETCH. et GARDN.) GEITL., *Kyrtuthrix dalmatica* ERCEG., *Calothrix pilosa* HARV., *C. codicola* SETCH. et GARDN., *Phormidium epiphyticum* GARDN., *Ph. constrictum* KLASS, *Lyngbya gracilis* RAB., *Microcoleus Boergesenii* (GARDN.) FRÉMY, *M. chthonoplastes* THUR., *M. tenerrimus* GOM., *Hydrocoleum cantharidosmum* (MONT.) GOM. and *Shizothrix lacustris* A. BRAUN are new to Japan.

The writer wishes to express his sincere thanks to Dr. Y. YONEDA, under whose direction this work has been carried on, and to Dr. Y. YAMADA of

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Hokkaido University, for kind advices during the course of the present study. Thanks are also due to Dr. H. UMINOMI who helped him with much kindness during his stay at the Marine Biological Laboratory.

### Enumeration of species

#### CYANOPHYCEAE

##### Chroococcaceae

1. *Chroococcus turgidus* (KUETZING) NAEGELI, Gatt. einzell. Alg. 46 (1849); GEITL., Cyan. in RABENH., Kryptogamenfl. 14: 228, figs. 109 b, 110 (1930).

*Hab.*: Seto (May 22; November 1). On rocks or among other Cyanophycean algae in the high tide level.

Bansho-ura (November 1). With other Cyanophyceae in the littoral belt.

Hatake-jima (August 2). Associated with *Calothrix pilosa* HARV. on rocks in the high tide level.

This species is fairly common in the Shirahama coast, and it was found on the every opportunity of collections in May, in August and November. The plants are mostly one, two and four-celled, but the eight-celled individuals are hardly observed. The cell membranes are hyaline, lamellated and up to  $3\mu$  in thickness. The cell contents are yellowish green, grass green or lavender blue and with often large dense granules.

2. *Ap'anocapsa littoralis* HANSRICH var. *macrococca* HANSRICH, Beitr. Kenntn. Meeresalg. u. Bact. Fl. 229 (1892); GEITL., Cyan. in RABENH., Kryptogamenfl. 14: 153 (1930); UMEZAKI, Journ. Jap. Bot. 27(7): 219 (1952).

*Hab.*: Seto (May 22). Growing on rocks in the littoral belt.

The mass of the colonies is irregularly and widely expanded on rocks, gelatinous and dark green in colour. The cells are densely scattered in the hyaline and gelatinous stratum, spherical or lengthwise longer, and  $6-10\mu$  in diameter. The cell membranes are hyaline and thin.

3. *Microcystis Reinboldii* (RICHT.) FORTI in DE TONI, Syll. Algar. 5:91 (1907); GEITL., Cyan. in RABENH., Kryptogamenfl. 14:134 (1930); FRÉMY, Cyan. Côtes d'Eur. 10, pl. 1, fig. 7 (1934).

*Hab.*: Hatake-jima (August 2). Growing on sands in the littoral belt in company with other Cyanophyceae.

This specimen forms a large, soft and membranous mass which aggregated into many small colonies among the filaments of other Cyanophyceae.

## Pleurocapsaceae

4. *Pleurocapsa minuta* GEITLER, Cyan. in RABENH., Kryptogamenfl. 14: 355, fig. 18 c-f (1931).

*Hab.*: Yuzaki (October 31). Growing on the fronds of *Kyrtuthrix dalmatica* ERCEG.

This plant was abundantly found among the upper portions of the fronds of *Kyrtuthrix dalmatica* ERCEG. The cells are 2.5–7.5  $\mu$  in diameter, and mouse colour or greyish green in colour. Almost the characteristics of this material are the very same as the diagnosis and figures given by GEITLER, though it is different from Dalmatia specimen in habit.

5. *Pleurocapsa fuliginosa* HAUCK, Meeresalg. in RABENH., Kryptogamenfl. 2: 515, fig. 231 (1885).

*Hab.*: Seto (May 22). Growing on rocks in the littoral belt.

This specimen is scarcely found, but it agrees with the description and figure given by HAUCK in many characteristics.

6. *Xenococcus Gilkeyae* SETCHELL et GARDNER, in GARDNER, Univ. Calif. Publ. Bot. 6: 462, pl. 39, fig. 11 (1918); UMEZAKI, Journ. Jap. Bot. 27 (7): 220, fig. 20 (1952).

*Hab.*: Seto (August 3). On the filaments of *Lyngbya semiplena* J. AG., which grow on rocks in the littoral belt.

Yuzaki (October 31). On the filaments of *Lyngbya semiplena* J. AG., *L. confervoides* C. AG. and *L. lutea* (AG.) GOM.

These specimens are typical in all characteristics, and the plants are fairly commonly found on the filaments of the genus *Lyngbya* in this region.

7. *Oncobyrsa adriatica* HAUCK, Meeresalg. in RABENH., Kryptogamenfl. 2: 515, fig. 230 (1886); INAGAKI, 14th general Meet. of Bot. Soc. Jap. (Lecture, April 1950).

*Japanese name*: Iwahige-no-kobu (K. INAGAKI).

*Hab.*: Seto (November 2). On a shell in the littoral belt.

In the material, the fronds were found on a shell, and up to 3 mm in diameter. Though they differ from the reports of other collectors till now in habit, the other characteristics are the very same as those of the specimens which were sent to the writer from Mr. K. INAGAKI, who collected at Cape Mikawa-irako, Aichi Prefecture in 1950, growing epiphytically on *Myelophycus caespitosus* (HARV.) KJELLM.

8. *Hyella Balani* LEHMANN, Ueber *Hyella Balani* in Nyt. Mag. Naturvid. 41: 85, pl. 2, figs. 1–2 (1902); GEITL., Cyan. in RABENH., Kryptogamenfl. 14: 370, fig. 199 (1931).

*Hab.*: Seto (May 22). Growing on an Oyster living in the high tide level.

A part of the filaments penetrates into the shell of an Oyster, and the

filaments are irregularly or dichotomously branched, blue green in colour. The membranes are thick, hyaline and not lamellated. The cells are  $4-8\mu$  in diameter, and short, spherical or rectangular, varying in shape. The end cells of the penetrating filaments are long, often up to  $20\mu$  in length. The sporangium is not observed in the materials at hand.

9. *Myxohyella socialis* (SETCHELL et GARDNER) GEITLER, Beih. Bot. Centralbl. 2 (41) : 247 (1927) ; UMEZAKI, Journ. Jap. Bot. 27 (7) : 220, fig. 21 (1952).

*Hyella socialis* SETCH. et GARDN. in GARDNER, Univ. Calif. Publ. Bot. 6 : 443, pl. 36, fig. 5 (1918).

*Hab.*: Seto (May 22). Endophytic in a red alga, *Polysiphonia* sp.

This plant is an endophytic species growing under the epidermis of *Polysiphonia*, irregularly branching in the host, and reaching  $100-200\mu$  in length. The cells are rectangular or mostly depressed in shape and  $3.5-6\mu$  in diameter. The terminal cells of this plant are often ellipsoidal or somewhat longer than those of the descriptions and figures given by GARDNER, and sometimes measuring  $20\mu$  in length. The sporangium is unknown. Other characteristics of this material, however, agree very well with GARDNER's descriptions.

### Dermocarpaceae

10. *Democarpa Leibleiniae* (REINSCH) BORNET et THURET, Notes algol. 2 : 73, pl. 25, figs. 3-5 (1880) ; GEITL., Cyan. in RABENH., Kryptogamenfl. 14 : 399, fig. 224 (1931) ; UMEZAKI, Journ. Jap. Bot. 25 (9-12) : 225, fig. 3 (1950).

*Hab.*: Seto (August 3). Epiphytic on *Sphacelaria* sp. and *Cladophora* sp. in the littoral zone.

In Japan, this species was for the first time discovered by the writer from Wakasa-takahama, Wakasa Bay, Fukui Prefecture, in 1950, and it was abundantly found growing on the plants of *Sphacelaria* and *Cladophora* by the present collection from Seto. The cells are from ovoid to long pear-shape,  $9-16\mu$  in diameter at the apex and  $15.5-21\mu$  in length. The membranes are  $1.5-3.5\mu$  in thickness, hyaline and conspicuously lamellated. Their mature sporangia are  $11-18\mu$  in diameter at the apex,  $20-30\mu$  in length and contain 5-18 endospores with a diameter from  $2.5\mu$  to  $5.5\mu$ .

### Mastigocladaceae

11. *Brachytrichia Quoyi* (AGARDH) BORNET et FLAHAULT, R v. Nost. het. 2 : 373 (1886) ; GEITL., Cyan. in RABENH., Kryptogamenfl. 14 : 554, figs. 347, 348 (1931).

Japanese name: Aimidori (K. OKAMURA).

Hab.: Seto (May 22). On rocks in the lower to upper littoral belt.

This species are, according to Dr. H. UENOMI, abundantly found during the spring season, from March to June. The fronds are less than 2 cm. in diameter. The writer observed in the fronds of *Nemalion multifidum* (W. et M.) J. AG. the very same plants as those which were figured and described as young plant of *Hormactis Balani* by BORNET and THURET (Notes algol. pl. 44, figs. 1-2, 1878). But, such a plant could not be found on rocks. It is doubtful whether the plants which were found in *Nemalion multifidum* are young plants of *Brachytrichia Quoyi* or other Cyanophycean species. For the determination, it certainly seems necessary to perform a developmental experiment in culture of this species.

In 1932, N. GARDNER gave a detailed note on the genus *Brachytrichia*. As he pointed out in his report, the writer also can not agree with such a treatment made by L. GEITLER (in RABENHORST, Kryptogamenfl. 14: 554) who combined all the species into one. Moreover, the appropriate name in the combination seems to be *B. Quoyi* based upon *Nostoc Quoyi* of C. AGARDH.

12. *Kyrtuthrix dalmatica* ERCEGOVIĆ, Arch. f. Protok. 66 (1): 170, fig. 3 (1929); GEITL., Cyan. in RABENH., Kryptogamenfl. 14: 557, fig. 349 (1931).

*Brachytrichia dalmatica* (ERCEG.) FRÉMY, Cyan. Côtes d'Eur. 162, pl. 51, fig. 2 (1934).

Hab.: Throughout the coast of Shirahama (from March to December). On rocks in the high tide level or more upper.

The fronds are flatly and widely expanded on rocks, somewhat endolithic, blackish green in a fresh state, but black on drying and very hard. The filaments are up to  $255\mu$  in height,  $10-15.5\mu$  in diameter, mostly parallel and not readily separable by pressure. The sheaths are hyaline at the base of the filaments and light brown at the upper portion. The trichomes are single within a sheath, mostly parallelly or irregularly bending, and attenuating into a short and delicate hair above. The cells are  $2.5-9.5\mu$  in diameter,  $2.8-10.5\mu$  in length, and their shape are short, spherical, barrel-shaped or ellipsoidal. The heterocysts are intercalary, several in a trichome, and their shape are short, spherical or long ellipsoidal,  $6-10.5\mu$  in diameter and  $4.5-15.5\mu$  in length. The hormogonia are unknown.

This species is very commonly and abundantly found in the Shirahama coast, throughout the year. By reason of that young plant of *Hormactis Balani* THUR. has just the same morphological characters as those of adult plant of *Kyrtuthrix dalmatica* ERCEG. which was established by M. ERCEGOVIĆ in 1929 and also the latter alga quite resembles *Brachytrichia maculans* GOM., P. FRÉMY (1934) combined *Kyrtuthrix* with *Brachytrichia* and gave the name *B. dalmatica*.

(ERCEG.) FRÉMY. At present, remaining *Brachytrichia* and *Kyrtuthrix* as separate genus, both the genera seem to be valid from their ecological, morphological and developmental points.

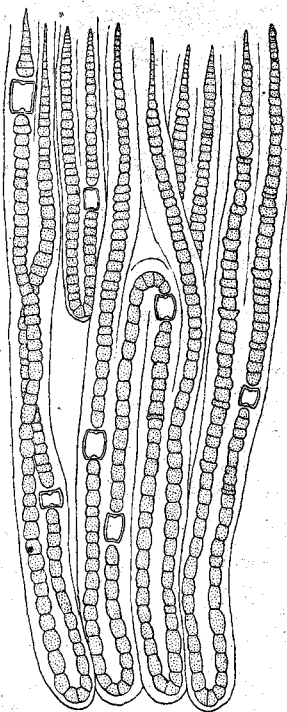


Fig. 1. *Kyrtuthrix dulmatica* ERCEGOV.Ć.  
Part of the vertical section of a thallus ( $\times 750$ ).

### Rivulariaceae

13. *Calothrix parasitica* (CHAUV.) THURET, Ess. Class. Nost. 381 (1875); BORN. et THUR., Notes algol. 2: 157, pl. 37, figs. 7-10 (1880).

*Hab.*: Seto (May 22). Growing in the fronds of *Nemalion multifidum* (W. et M.) J. AG., *N. pulvinatum* GRUN. and *Helminthocladia australis* HARV.

The morphological characteristics in each host of this species are typical. In the United States and Europe, this species is discovered in the fronds of various Rhodophyceae and Phaeophyceae, especially commonly in the fronds of *Nemalion multifidum* and *N. lubricum*. From this region, the writer found it in the fronds of *Nemalion multifidum*, *N. pulvinatum* and *Helminthocladia australis*. *Helminthocladia*, especially *Nemalion*, with the soft gelatinous fronds

seem to be favorable hosts for *C. parasitica*, probably due to some ecological relations between both the plants. As the result of parasitism of *C. parasitica*, the fronds of *Nemalion multifidum* show often blue green colour, as if it were a different alga.

14. *Calothrix pilosa* HARVEY, Ner. Bor. Amer. 3: 106, pl. 48 c (1858); FRÉMY, Dansk. Bot. Ark. 9 (7): 36, fig. 4 (1939).

*Hab.*: Seto, Hatake-jima, Ka-shima and Yuzaki (May 22; August 2; October 31). On rocks in the high tide level or a little above.

This species and *Kyrtuthrix dalmatica* ERCEG. are very common algae found on rocks of the uppermost tide belt in the Shirahama coast.

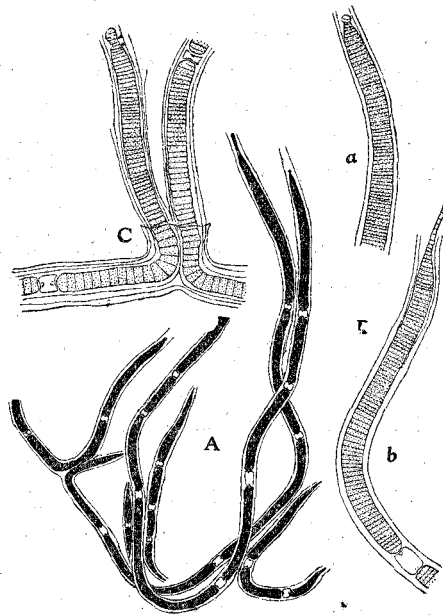


Fig. 2. *Calothrix pilosa* HARVEY. A, habit ( $\times 10$ ); B, upper portions of two filaments ( $\times 25$ ), a, ending to a button-like apex, b, ending to a hair at the end of trichome; C, part of a filament showing a scytonemous pseudobranching ( $\times 25$ ).

The filaments form a widely and densely expanded, intricate, dark green stratum on rocks, black on drying, decumbent at the middle, both ends erect upwards, up to 5 mm in height,  $30-43\mu$  in diameter, often attaching one another with their sides, and sometimes scytonemously pseudo-branched. The sheaths are yellow to light brown at the decumbent portions of the filaments, mostly hyaline at the erect portions, lamellated, and up to  $11\mu$  in thickness.



The trichomes are  $18-27.5\mu$  in diameter, blue-green to deep blue green, above briefly attenuated, and the end of the hair often button-like. The cross walls are usually constricted or often not. The dissepiments are not granulated. The cells are  $2.1-9.2\mu$  in length, and about  $\frac{1}{2}-\frac{1}{9}$  ( $-\frac{1}{12}$ ) time as long as the diameter. The cell contents often with large, dense granules. The heterocysts are intercalary, numerous,  $9-47\mu$  in length, and short, quadrate or cylindrical in shape.—Fig. 2.

15. *Calothrix codicola* SETCHELL et GARDNER, Proc. Calif. Acad. Sci. IV, 19 (11): 124, pl. 4, fig. 4 (1930).

*Hab.*: Senryo-jiki (October 31). Among other Cyanophycean algae growing on rocks of a small tide pool, in the high tide level.

The materials at hand were found growing among the fronds of *Hydrocoleum* and other Cyanophycean algae. The filaments are  $300-440\mu$  in length,  $12-18\mu$  in diameter at the slightly thickened base, and  $9-12\mu$  in diameter at the middle. The sheaths are hyaline, thin or often thick, and up to  $3\mu$  in thickness. The trichomes are  $9-12\mu$  in diameter at the base,  $4.5-6.5\mu$  in diameter at the middle, and their ends are tapering into a short or often long delicate hair.

This material differs from the original diagnosis in habit, but in other characteristics, it rather seems to belong to *Calothrix codicola* than the other species of *Calothrix*.

16. *Isactis plana* (HARVEY) THURET in BORN. et THUR., Notes algol. 2: 163, pl. 40 (1880).

From the Shirahama coast, the following two varieties were collected.

a). var. *fissurata* BORN. et FLAH., Rév. 2: 344 (1886).

*Hab.*: Yuzaki (May 22). Growing on *Helminthocladia australis* HARV.

Seto (May 22). Growing on rocks in the littoral belt.

Specimens on *Helminthocladia australis*: The filaments are  $270-330\mu$  in height and blue-green in colour. The sheaths are hyaline. The trichomes are  $6-9\mu$  in diameter at the base, and  $3.5-8.5\mu$  in diameter at the middle.

Specimens on rocks: The filaments are about  $400\mu$  in height. The sheaths are light brown at the upper portion, and hyaline at the base. The trichomes are  $4.5-11\mu$  in diameter at the base, and  $4-6\mu$  in diameter at the middle.

b). var. *plana* BORN. et FLAH., Rév. 2: 344 (1886).

*Hab.*: Yuzaki (May 22). Growing on pebbles in the littoral belt.

The height of the filaments are from  $200\mu$  to  $220\mu$ . The trichomes are  $6-10.5\mu$  in diameter at the base, and  $5-8\mu$  in diameter at the middle. The cross walls are conspicuously constricted. The sheaths are yellowish brown in colour, and thick. The cells are  $\frac{1}{3}-1$  time as long as the diameter.

17. *Rivularia atra* ROTH in GEITLER, Cyan. in RAPENH., Kryptogamenfl. 14: 645, fig. 410 b, c (1931).

*Hab.*: Seto (November 2). On rocks in the lower littoral belt.

The fronds are blackish green, hemispherical in shape, very hard, individual plants up to 0.5 cm. in diameter, and masses formed by mutual union up to 1 cm in diameter. The sheaths are hyaline, thick, up to  $4.5\mu$  in thickness, and opening instead of vanishing at the apex. The trichomes are crowded, not separable by pressure,  $2-5.5\mu$  in diameter at the inner part of the frond,  $4.5-6\mu$  in diameter at the outer part of the frond, and tapering into a long hyaline delicate hair above. The cells are  $2-3\mu$  in length at the apex of the trichome in the outer part of the frond,  $1-\frac{1}{3}$  time as long as the diameter, mostly  $7.5-18\mu$ , but sometimes up to  $33\mu$  in length at the inner part of the frond, mostly 2.5-6 times, but sometimes 6-11 times as long as the diameter. The heterocysts are basal. The basal heterocysts are usually single, sometimes up to three in series, spherical or hemispherical, and  $5-11\mu$  in diameter. The arrangement of the basal heterocysts shows usually concentric zonations in vertical section of the frond.

*Rivularia atra* ROTH is common in the Shirahama coast, and it is very common in the Japanese coast as described in "Synoptic List of Japanese Algae" by the late Dr. K. OKAMURA (1916).

### Oscillatoriaceae

18. *Spirulina socialis* GARDNER, Sci. Surv. Porto Rico & Virgin Isl. 8 (2): 272, pl. 1, fig. 1 (1932); UMEZAKI, Journ. Jap. Bot. 27 (7): 221, fig. 22 (1952).

*Hab.*: Seto (August 3). Epiphytic on *Hydrocoleum lyngbyaceum* which grows on rocks in the littoral belt.

The characteristics of this material are typical, and agree well with the descriptions given by GARDNER. The plants form solitary or mostly gregarious colonies on the sheath of *Hydrocoleum lyngbyaceum*, and their trichomes are lengthwise parallelly epiphytic on host sheath.

19. *Oscillatoria chalybea* MERTENS var. *anguina* GOMONT, Monogr. des Oscill. 233 (1892); UMEZAKI, Journ. Jap. Bot. 27 (4): 117, fig. 17 C (1952).

*Hab.*: Ka-shima (August 2). Among the filaments of *Hydrocoleum lyngbyaceum* on rocks in the littoral belt.

The trichomes are yellowish green, loosely and irregularly spiral or sometimes twisted, and  $9-12\mu$  in breadth. The cells are  $3-6.4\mu$  in length, and  $\frac{1}{2}-\frac{1}{3}$  time as long as the diameter.

20. *Oscillatoria laetevirens* (CROUAN) GOMONT, Monogr. des Oscill. 226, pl. 7, fig. 11 (1892); UMEZAKI, Journ. Jap. Bot. 26 (9): 267, fig. 13 B (1951).

*Hab.*: Seto (May 22). Among other Cyanophyceae growing on oyster shells in the littoral belt.

A few materials were found among the fronds of *Calothrix* or other Cyanophycean algae. The trichomes are  $2.6-4\mu$  in diameter, and  $2.5-4.5\mu$  in length, and their apical cells are long, and  $2.5-6.6\mu$  in length.

21. *Oscillatoria nigro-viridis* THWAITES in GOMONT, Monogr. des Oscill. 217, pl. 6, fig. 20 (1892); UMEZAKI, Journ. Jap. Bot. 26 (9): 267, fig. 13 A (1951).

*Japanese name*: Kuro-yuremo (I. UMEZAKI).

*Hab.*: Bansho-zaki (November 2). With other Cyanophyceae on rocks in the littoral belt.

The plants were rarely observed among other Cyanophyceae. The trichomes are  $7-9\mu$  in diameter. The cells are  $2.5-4.5\mu$  in length. Other characteristics are typical.

22. *Oscillatoria Corallinae* (KUETZING) GOMONT, Monogr. des Oscill. 218, pl. 6, fig. 21 (1892); UMEZAKI, Journ. Jap. Bot. 26 (9): 263, fig. 13 C (1951).

*Hab.*: Seto (May 22; November 2). On *Corallina* sp. in the littoral belt. Yuzaki (October 31). Among the mass of *Calothrix pilosa* HARV.

The materials were rarely found.

23. *Phormidium epiphyticum* GARDNER, Sci. Surv. Porto Rico & Virgin Isl. 8 (2): 281, pl. 1, fig. 1 (1932).

*Hab.*: Senryo-jiki (October 31). On the sheaths of *Hydrocoleum lyngbyaceum* KUETZ. which grows on rocks of a small tide pool, in the high tide belt.

The filaments of this species are very densely and parallelly encircling the sheaths of *Hydrocoleum lyngbyaceum* Kuetz. The characteristics are typical.

24. *Phormidium constrictum* KLAS, Acta Adriat. 2 (2): 77, fig. 2 (1938).

*Phormidium nostochoides* JAO, Bot. Bull. Acad. Sinica 2: 169, fig. 1 g (1948).

*Hab.*: Hatake-jima (August 2). On rocks in the littoral belt.

The plants form an irregularly expanded, olive-green and somewhat membranous stratum on rocks. The filaments are irregularly intricated. The sheaths are hyaline, thin when young, later thick, not lamellated, and not diffuent. The trichomes are  $1-1.7\mu$  in diameter, and not attenuating at the terminals. The cross walls are conspicuously constricted. The dissepiments are not granulated. The protoplasm is light blue-green. The end cells of the trichomes are neither capitated nor calyptrated.

*Phormidium constrictum* was described as new by Z. KLAS from the Adriatic Sea, Europe in 1938. C. JAO, in 1948, reported *Phormidium nostochoides* as new based on the materials collected from San Juan Island, Washington, U.S.A. in

1935. The writer collected an alga from the Shirahama coast having exactly the same features as the descriptions and figures given by them. From the observations of this material and comparative studies between both the specific diagnoses described by them, these two species seem most probably to be identified as one. So, according to the principle of the priority of publication, the specific name *Phormidium constrictum* given by Z. KLAS should be used.

25. *Lyngbya Kuetzingii* SCHMIDLE. Allg. Bot. Zeitschr. 58 (1879); UMEZAKI, Journ. Jap. Bot. 26 (7) : 203, fig. 7 (1951).

*Japanese name:* Tachi-ringubia (I. UMEZAKI).

*Hab.:* Seto (May 22; November 2). Growing on *Cladophora* sp. in the littoral belt.

The characteristics in this material are typical. In Japan, this species was first found growing epiphytically on *Pilthophora* sp. by Dr. Y. YONEDA from Takemoto Spring in 1938, and the writer rediscovered it growing on *Gelidium* sp. from Maizuru Bay in the Japan Sea coast in July 1951, and by the present collection he has found it again from marine as mentioned above.

26. *Lyngbya Nordgardhii* WILLE. Nyt. Mag. Naturv. 55: 32 (1917); UMEZAKI, Journ. Jap. Bot. 26 (7) : 203, fig. 8 (1951).

*Hab.:* Seto (May 22). Growing on *Cladophora* sp. and young plants of *Enteromorpha* sp. near the high tide level.

This species was published by the writer from Kunda Bay, Kyoto Prefecture as new record for Japan, July 1951. The characteristics are entirely similar to the typical form.

27. *Lyngbya epiphytica* HIERONYM. in ENGLER-Plantl, Nat. Pflanzenf. 1 (1 a) : 67 (1898); UMEZAKI, Journ. Jap. Bot. 25 (9-12) : 226, fig. 5 (1950).

*Japanese name:* Itomakimo (I. UMEZAKI).

*Hab.:* Seto (May 22). Growing on the filaments of *Hydrocoleum caniharidosmum* (MONT.) GOM. and other filamentous Cyanophyceae in the littoral belt.

This species is a fairly common alga encircling other filamentous Cyanophyceae. In every characteristic the plant agrees well with the original diagnosis.

28. *Lyngbya gracilis* RABENHORST in GOMONT, Monogr. des Oscill. 124, pl. 2, fig. 20 (1892).

*Hab.:* Seto (May 22; August 3). Growing on *Calothrix* sp. and *Cladophora* sp. in the littoral belt.

The plants were rarely found growing on other algae. The trichomes are  $5-6.5\mu$  in diameter, lavender blue and not or slightly constricted at the cross walls. The cells are  $2.5-6\mu$  in length,  $1-\frac{1}{2}$  time as long as the diameter.

29. *Lyngbya sordida* (ZANARD.) GOMONT, Monogr. des Oscill. 126, pl. 2, figs. 21 (1892); UMEZAKI, Journ. Jap. Bot. 25 (9-12): 227, fig. 6 (1950).

*Hab.*: Seto (May 22). On *Corallina* sp. in the littoral belt.

This plant was rarely found, associated with other Cyanophycean algae on *Corallina* sp.

30. *Lyngbya semiplena* J. AG. in GOMONT, Monogr. des Oscill. 138, pl. 3, figs. 7-11 (1892); UMEZAKI, Journ. Jap. Bot. 26 (7): 204, fig. 10 (1951).

*Hab.*: Seto (August 3; November 1); Yuzaki (October 31). On rocks in the littoral belt.

Seto specimens have the filaments about 2 cm. high, 10-15  $\mu$  broad, and the trichomes 6-12  $\mu$  in diameter, and the sheaths 2-4  $\mu$  in thickness. Yuzaki specimens have the filaments from 0.5 cm. to 1 cm. in length, 8.5-12.5  $\mu$  in diameter, and the trichomes 6-9  $\mu$  in diameter, and the sheaths 1-3  $\mu$  in thickness. The species is common in this region.

31. *Lyngbya lutea* (AGARDH) GOMONT, Monogr. des Oscill. 141, pl. 3, figs. 12-13 (1892); UMEZAKI, Journ. Jap. Bot. 26 (7): 204, fig. 11 (1951).

*Hab.*: Seto (August 3, November 1). On rocks or intermixed among the filaments of *Cladophora* sp.

Yuzaki (October 31). On rocks with other Cyanophyceae in the littoral belt.

The filaments are intermixed with other Cyanophyceae among the filaments of *Cladophora* sp. or expanded on rocks, and they are 5-8  $\mu$  in diameter. The trichomes are 2.8-4.7  $\mu$  in diameter and their cross walls are often conspicuous.

32. *Lyngbya confervoides* C. AGARDH in GOMONT, Monogr. des Oscill. 136, pl. 3, figs. 5, 6 (1892); UMEZAKI, Journ. Jap. Bot. 26 (7): 204, fig. 9 (1951).

*Hab.*: Yuzaki (October 31); Seto (November 1). Growing on rocks of a small tide pool, in the high tide level.

This plant is a common and the largest species of this genus collected from this coast. The filaments of the present materials form a widely expanded and olive green tuft, from 3 cm. to 5 cm. in length, and 15-29  $\mu$  in diameter. The trichomes varies from 13  $\mu$  to 17  $\mu$  in diameter. Their other characteristics are typical.

33. *Microcoleus Boergesenii* (GARDNER) FRÉMY, Dansk Botanik Arkiv. 9 (7): 12, fig. 1 (1939); UMEZAKI, Journ. Jap. Bot. 27 (4): 119, fig. 17 G (1952).

*Hydrocoleum Boergesenii* GARDN., Sci. Surv. Porto Rico & Virgin Isl. 8 (2): 289 (1932).

*Hab.*: Seto (May 21). On *Ulva conglobata* KJELLM. growing in the littoral belt.

The writer has found only a single filament growing on *Ulva conglobata* KJELLM. The filament is  $49\mu$  in diameter at the broadest portion. The trichomes are light aeruginous,  $6-6.6\mu$  in diameter, and densely entwined within the sheath. The cells are  $1.8-2.6\mu$  in length.

For the first time, this species was published as *Hydrocoleum Boergesenii* by N. GARDNER in 1932 based on the specimen collected from the Danish West Indies by Dr. BOERGENSEN. Afterwards, *Hydrocoleum Boergesenii* was combined to the genus *Microcoleus* by P. FRÉMY in 1939, and he gave a detailed diagnosis and figure to this species.

**34. *Microcoleus chthonoplastes* THURET in GOMONT, Monogr. des Oscill. 353, pl. 14, figs. 5-8 (1892); UMEZAKI, Journ. Jap. Bot. 27 (7): 221, fig. 23 (1952).**

*Hab.*: Seto (August 3). On rocks or *Hypnea pinnosa* J. AG. in the littoral belt.

Bansho-zaki (November 1). Growing in associating with other Cyanophyceae on rocks.

The plants widely expand on rocks or other algae, and they show dirty yellowish green colour. The trichomes are mostly  $2.5-4.5\mu$  in diameter, but sometimes up to  $6\mu$ . The cells measure  $3.7-7.5\mu$  in length, and 1-2 times as long as the diameter.

**35. *Microcoleus tenerrimus* GOMONT, Monogr. des Oscill. 355, pl. 14, fig. 9-11 (1892); UMEZAKI, Journ. Jap. Bot. 27 (4): 119, fig. 17 F (1952).**

*Hab.*: Seto (May 22; November 2). Among the filaments of *Hydrocoleum lyngbyaceum* KUETZ. growing on rocks in the littoral belt.

Almost all the characteristics of this plant at hand are typical

**36. *Microcoleus tenerrimus* GOMONT var. *longus* UMEZAKI var. nov.**

Fila solitaria, aeruginea, simplicia vel parce pseudo-ramosa. Vaginae hyalinae, amplae, apice acuminatae, aut apertae, interdum omnino diffuentes. Trichomata dilute aeruginea, intra vaginam pauca,  $1.5-2\mu$  crassa, apice saepius longissime attenuata; ad genicula constricta; dissepimenta pellucida, non granulata; articuli longiores quam latiores,  $4-9\mu$  longi,  $2.5-6$ -plo longiores quam latiores. Cellula apicalis haud capitata, acutissime conica.

Filaments solitarily dispersed among other Cyanophycean strata, aeruginous in colour, simple or sparsely pseudo-branched. Sheaths hyaline, ample, apices acuminate or open and blunt, sometimes entirely diffuent. Trichomes light aeruginous, generally 2-10 within a sheath,  $1.5-2\mu$  in diameter, apices frequently long attenuate; cross walls constricted; dissepiments pellucid, not granulated; cells much longer than the diameter,  $4-9\mu$  in length, 2.5-6 times as long as the diameter. Apical cells not capitate, very acute conical.

*Hab.*: Seto (May 22). Among the strata of *Microcoleus tenerrimus* GOM. and other Cyanophyceae which grow on rocks in the littoral belt.

This new variety of *Microcoleus tenerrimus* GOM. is distinguished from the species by its much longer cells and containing the fewer trichomes within a sheath. — Fig 3.

**37. *Hydrocoleum cantharidosmum* (MONT.) GOMONT**, Monogr. des Oscill. 336, pl. 12, figs. 6, 7 (1892).

*Hab.*: Seto (May 22). Intermixed with other Cyanophyceae on rocks.

The filaments form an olive green, mucous stratum. The sheaths are very mucous or often diffuent. The trichomes are  $18-22\mu$  in diameter, and 1-4 within the sheath. The cells are very short,  $1.5-3\mu$  in length and  $\frac{1}{6}-\frac{1}{10}$  time as long as the diameter. Other characteristics are typical.

**38. *Hydrocoleum lyngbyaceum* KUETZING in GOMONT**, Monogr. des Oscill. 337, pl. 12, figs. 8-10 (1892); UMEZAKI, Journ. Jap. Bot. 26 (9): 269, fig. 16 (1951).

*Hab.*: Seto (May 22; August 3). On rocks or oyster in the littoral belt.

Ka-shima (August 2). On rocks in the littoral belt.

Senjyo-jiki (October 31). On rocks in a small tide pool in the high tide level.

The fronds are widely expanded and very mucous. The sheaths are hyaline, very mucous, often almost diffuent, and owing to its diffuence, filaments are often dispersed by slight pressure. The diameter of the trichomes is from  $9\mu$  to  $15\mu$ . This species is very commonly found in this coast.

**39. *Schizothrix lacustris* A. BRAUN in GOMONT**, Monogr. des Oscill. 301, pl. 6, figs. 9-12 (1892); UMEZAKI, Journ. Jap. Bot. 27 (7): 222, fig. 24 (1952).

*Hab.*: Seto (May 23). On rocks with other Cyanophyceae in the littoral belt.

The materials were rarely found among other Cyanophycean algae. The filaments are mostly branched at the upper portion, and up to 1 mm. in length. The trichomes are  $1-1.5\mu$  in diameter and not attenuated at their end portions. The cells are up to  $4\mu$  in length, quadrate or 2-3 times longer than the diameter.

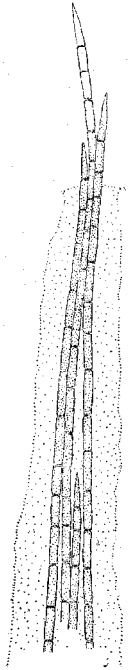


Fig. 3. *Microcoleus tenerrimus* GOM. var. *longus* UMEZAKI. Upper portion of a filament ( $\times 750$ ).